Feasibility of Sustainable Reconstruction and Fit-up for Third Sector New England's Non-Profit Center

Third Sector New England

Principle Authors

Mark E. Kelley III, PE

The Hickory Consortium

and

Martine Dion, AIA, LEED AP

Symmes Maini & McKee Associates

Lincoln Plaza - 89 South Street – Boston MA 02111 – 617-523-6565

Table of Contents

Introduction:

Third Sector New England (TSNE) is a nonprofit organization dedicated to supporting the nonprofit community. TSNE provides information and services to build the knowledge, power, and effectiveness of nonprofit organizations that engage people in community and public life. Third Sector New England also acts to promote wider recognition of community-based organizations as the primary stewards of core societal values. TSNE seeks to promote the diversity and richness of the non-profit sector by supporting the variety of activities that happen within it. The ultimate intention of our work is to create a more just and democratic society.

Third Sector New England has had a 10-year vision to develop the first mission-based Non-Profit Center in Massachusetts. After two years of intense planning and an extensive search, this vision has been realized with the purchase of One Lincoln Plaza (89 South Street), an exceptional property located in the South Station/Leather District area.

The mission of the Nonprofit Center is to provide stable, affordable rents, to create an environment that fosters collaboration, and to raise the visibility of the non-profit sector. TSNE is renovating a large portion of Lincoln Plaza.

The Center will provide secure, affordable space, shared office building core areas, high-quality shared conference space, and access to management and administrative services. In addition, the Center will facilitate events aimed at building community among tenant organizations and promoting linkages across the third sector and with government and business sectors. Through all of Third Sector's work, there runs the thread of seeking to create a more just and democratic society. Sustainable design embodies the values of justice and community through principles of construction that emphasize environment, health, intergenerational equity, and fiscal responsibility. For that reason, this renovation has as a fundamental goal the pursuit of sustainable construction practices.

Sustainable building provides an organizing principle that must be used to plan for a stable future, a healthy environment, durable, affordable buildings and vibrant communities. Using resources wisely to establish a continuous cycle of use and renewal is at the center of this principle. To a building sector that has thrived on the exploitation of natural resources and natural waste disposal sites during the construction and occupancy periods, sustainability means living within the carrying capacity of our environment. To the occupants of sustainably designed buildings, it means better health, a more pleasant living environment, lower use and occupancy costs, increased environmental equity and responsibility, and a supportive community.

Since sustainable design is a significant goal for Third Sector New England, energy efficiency and sustainable construction are being pursued in the redesign and rehabilitation of this building. Consequently, the design team has employed a comprehensive approach to materials, energy, and lighting, ventilation, elevator, and water and appliance systems in order to maximize the opportunity inherent in the redevelopment of this building. This integrated design approach has followed principles delineated in the USGBC LEED program, including measures from the LEED Existing

Buildings Certification system and the pilot LEED Commercial Interiors System. Because the building will be finished in stages with four floors part of the initial phase, the LEED Commercial Interiors standard was chosen as the compliance path.

Lincoln Plaza is a complex of two attached buildings located at 70-80 Lincoln and 89 South Street. The buildings date from 1899 and 1894 respectively. The complex was fully renovated in 1986. TSNE has purchased seventy-five percent of the 89 South Street property and owns 122,752 gross square feet. The building consists of nine floors of approximately 13,300 square feet per floor, including a finished basement. Because of the quality of those renovations, it earned the Award of Excellence from the National Commercial Builders Council. In addition, the property is listed on the National Register of Historic Places for its fully restored, architecturally distinctive facade. The Lincoln Street property was purchased by a developer and is being converted to residential condominiums.

It is TSNE's intention to create a showcase of best practices and sustainable "green design" for our tenants and the larger community. The goal of TSNE is to extend the normal limits of life cycle cost assessment because low operating cost is a key element in TSNE's pledge to nonprofit tenants. For that reason, we are willing to look at longer-term payback on measures that save significant amounts of energy. Systems throughout the building are at the end of their useful life, with heat pumps, chillers, lighting, ventilation, and other systems due for replacement or repair. This provides a good opportunity to replace existing equipment with higher efficiency, more environmentally sound systems.

Participants in the Green Design Team:

Project Manager: Marie Manis, Third Sector New England.

Sustainability design support:

The Hickory Consortium was chosen as the primary consultant for sustainable practices. The Hickory Consortium is a group of experienced building professionals and companies dedicated to fostering innovation in the building industry. Hickory's mission is to catalyze the practice of building energy-efficient, environmentally sound, and healthy buildings. Hickory is dedicated to building sustain-ably at a cost comparable to traditional building methods and at equal or higher quality.

The Hickory Consortium works vigorously with the public sector to advance the use of green construction practices. This is accomplished through planning, designing and managing the construction of buildings. Hickory's partners include non-profit developers, local governments, buildings financers, and city agencies. Some of Hickory's projects, like the flagship multi-family project at Erie Ellington, are prototypes that are considered so successful they serve as models for sustainable development internationally.

Construction Management Consultant: Jennifer Pinck, Pinck Associates. Jennifer Pinck provides construction management consulting services to the owner, TSNE with an emphasis on design, value engineering, bid award and/or negotiation, and construction oversight.

She is engaged in the day-to-day management of the project, applying broad experience in planning, design, construction and multiple contract management, as well as procurement, environmental requirements, and industrial/government relations. Jennifer provides project management and guidance for the design and construction process to facilitate the move to the new offices.

Architect/Engineer:

The architectural firm chosen to design and manage the project is Symmes, Maini and McKee, Architects (SMMA). SMMA is a fully integrated design firm dedicated to all aspects of sustainable design. SMMA actively builds its knowledge in new practices, and always with the intent of providing measurable value to buildings and their clients. Their LEED TM Accredited staff are recognized experts and are active in the industry writing articles, and lecturing on the topic of sustainability. As a full service design firm, they are especially positioned to understand the connected nature of building systems.

Sustainable Design Planning and Priorities

At the beginning of December 2003, two design sessions were conducted by the Hickory Consortium with Third Sector New England, its design team, and its prospective tenants, to consider the prioritization of design issues for the new Non-Profit Center building. The goal of the meetings was to develop consensus on the relevant issues to be pursued in the design and rehabilitation of the building. The meetings began with discussion of issues related to sustainability, costs, energy and utility of the building. After some discussion, the group listed areas of interest in choosing and remodeling the new building, and began to consider the importance of each from a variety of standpoints. Following review of the issues and discussion of these standpoints, we entered into an exercise to establish priorities to guide the architect in making design decisions. The exercise proceeded as follows:

The workshops: The first meeting began with discussion of issues related to sustainability. Sustainability can be defined as the ability of a system to maintain itself in a whole and functioning well over a long period. We discussed the definition of sustainability as a condition achieved by a community in which the activities of the current generation lead to improvement of the prosperity of succeeding generations. Since this is at the heart of Third Sector New England's mission, it is of particular interest to this group. For Third Sector's community of non-profit organizations, this suggests supporting efforts to articulate and implement a clear vision of organizational mission to guide common evolution toward a shared community vision. Third Sector has already embarked on the process through establishment of a clear mission and goals, including that of creating a non-profit center. At the level of a building project, this shared community vision means thinking of long-term environmental impacts, building and occupant uses of resources, and costs of ownership, maintenance, and operations.

In the first session, we reviewed the concepts of sustainable building and the reasons behind it. As a group, we discussed the issues that were of particular importance to the attendees. After listing the issues for the new building, we took a weeklong break to consider the issues and to aggregate similar points on the list before beginning to select the most important ones. At the next session, we selected the highest priorities from three points of view. Each of those present was given a number of dots to allocate to the issues of most importance. The first viewpoint was from a global environment point of view, typically the most important standpoint in building design. Keeping the global environment in mind, each participant distributed his or her dots among those issues of greatest importance. Next, the same procedure was used to prioritize from the standpoint of the cost of owning and operating the building. Finally, we discussed the question of what would be the most appropriate viewpoint for a building from the standpoint of the goals of Third Sector New England and the non-profit tenants of the building. We agreed that the long-term perspective was the key to making the best decisions about priorities. With this image in mind, the group proceeded to allocate points to the most important issues when viewed from the future. This, of course, represents a powerful incentive to put sustainability first, and so it turned out. However, what also emerged is an understanding of sustainability in terms of sustaining the operation itself and the success of the community and its member organizations as going concerns.

The results of the prioritization session are tabulated below:

	Global	Cost	Organizational best interest	Sum of All votes	Overall Rank
Sustainable Sites	33	37	32	102	A
Energy and Atmosphere	35	39	23	97	B
Comfort & Health	13	18	24	55	C
Livability/functionality	6	11	19	36	D
Materials and Resources	19	11	5	35	E
Water Efficiency	13	10	5	28	F
Education	12	2	12	26	G

Table 1

Sustainable sites, the highest priority for the attendees, consisted of two primary factors: Reuse of an existing building and transportation issues. The reuse of an existing building means that new land will not be sacrificed, that the building will not use as many resources in construction, and that it will be in a downtown urban location. This also offers the opportunity to enhance the community surrounding the building and provide local services. Transportation related issues included most importantly public transportation access, as well as bicycle storage and showers, pedestrian access, and innovative transportation options such as zip car or alternative vehicles.

Energy and atmosphere were second on the list, though they were first in both the cost and global ranking, showing great importance to most of those present. There is no doubt that the conservation of energy will help reduce the owning and operating costs and therefore the rents, but also note that if energy costs are low, their impact on the growth of rents will be diminished as well. Design to reduce equipment energy loads and waste energy can allow downsizing of mechanical equipment resulting in lower first costs and maintenance. Reduction of energy reduces atmospheric pollution, since much of the pollution in the world derives from energy production and use. The sustainable building design process results in reduced environmental impact including avoided air pollution emissions, better indoor air quality, less materials waste, better energy integrity and wise use of water and natural energy sources to improve performance. By integrating the architecture, mechanical equipment and lighting, economies are frequently realized in design. It often turns out that saving energy can actually free more of the budget to spend on energy conservation materials and design. The energy savings can result in lower total lifecycle costs for the building. Economics alone can justify the additional effort and expense, but the value is far greater than simple economics would indicate. The added value includes greater comfort, durability, health, a better living environment and a better global environment.

Comfort and health ranked third on the list and second in the interest of the tenant organization's long-term good. There was some particular interest in indoor air quality and health, plus considerable interest in the multiple value of day lighting for energy, comfort and health. Many expressed an interest in operable windows, combining a perception of need for fresh air with the view and daylight advantages of windows. A key issue for renovation in existing buildings is day lighting. Day lighting is the use of natural light to replace electric light. Direct use of the sun's energy as light is the most efficient solar application, since no conversion of sunlight to another form of energy must take place. Integrating natural light and super-efficient electric lighting and controls may reduce the lighting energy use by as much as half. To the extent that day-lighting allows tradeoffs in lighting input to cooling loads, it may be possible to reduce the size of cooling equipment - since day-lighting availability is greatest at a time coincident with cooling peak load, and lumen for lumen, the wattage of sunlight is only 2/3 that of electric light.

In the area of comfort and health, it is vital to include good ventilation to bring fresh air to all the occupants while they work. Existing buildings may have ventilation systems, but many have none or poorly designed systems, and those built or rehabilitated before 1990 often lack adequate systems, since neither the code nor the standards of the day required the deliberate supply of fresh air in office buildings. Here is another example of a feature that improves health conditions within the building, but which has a real payback in improved productivity, comfort, alertness, and reduced absenteeism.

Next on the priorities list is livability and functionality. These issues include the quality of the indoor spaces, with great interest in adjustable or flexible spaces. There was considerable interest in mutual support aided by building design. This includes creating common spaces for interaction and sharing of equipment and facilities. Enhanced interior accessibility, flexibility and beauty were also of importance.

Materials and resources came next, with emphasis on non-toxic materials selection to maintain good indoor air quality. Sustainable materials choice also drew some interest in this category, and as far as possible without affecting costs, the choice of renewable, sustain-ably harvested, and recycled materials is encouraged.

Water efficiency came next with emphasis on fixtures that would reduce water use. This is particularly important in light of the increasing cost of water in the Boston area and the need to keep water and sewer costs low to restrict the growth of owning and operating costs.

Finally, the educational value of the building had a number of interested parties who hope that the sustainable features of the building can help others learn about the green building process and opportunities. Those who allocated points to this issue were most interested in making the building a sustainable building showplace, which could be a part of the features in the entry to the building with displays and/or callouts highlighting sustainable features.

For a wide variety of reasons, both idealistic and practical, the comprehensive approach to building known as sustainable design or green building is strongly recommended for buildings. We do not expect the leaders and stakeholders in every building project to initially embrace this approach, but we firmly believe it will result in a better building at no significant cost premium, and will ultimately be the standard for construction. Many buildings have been around for hundreds of years, and there is every reason to expect that any current project will also be in use for hundreds of years. This means that design with strong consideration for the future is the most rational approach.

Sustainable design can make a building more attractive inside and out, improve the comfort and quality of the indoor environment, improve community and global citizenship, and increase occupant health. Whole-building design is a systems approach to sustainable design that takes into account the interaction of the building, the environment, and the systems within the building. Whole- building design recognizes that the building is greater than the sum of its parts. In the final product, each part will interact with all the other parts and with its environment in many ways. Whether those systems work well or not depends on the planning, the design and the final execution. It is terribly hard to make up for bad planning in the construction phase. Efforts made in the initial planning stages will pay off in a major way at the end of the project. The ball to keep our eye on is the performance of the end product, refining plans, details, systems and materials to that end. Performance is simply the output of the system; in this case comfort, economy, functionality and well-being of the occupants and the environment.

Buildings are rarely designed with consideration of environment and energy, despite the sizeable costs that inefficient designs impose on the users. Experience shows that the goal of a higher-quality product at lower cost is achievable, and that the improved indoor environment results in greater occupant satisfaction. By integrating the architecture, mechanical equipment and lighting, economies are frequently realized. It often turns out that saving energy can actually free more of the budget to spend on materials, energy conservation, and design. The energy savings can result in lower total life cycle costs for the building. Economics alone can justify the additional effort and expense, but the value is far greater than simple economics would indicate. The benefit includes greater comfort, durability, health, productivity, a better interior environment and a better global environment. For the Third Sector New England Non-Profit Center, a major benefit will be the demonstration of the potential for sustainable design in existing buildings and in the lives of the community and visitors.

Whole Building Approach– the discipline explained:

The whole building approach involves looking at all parts of the building and the building process to reveal opportunities to improve the building at the lowest possible cost. The first step is to include owners, tenants, designers and other stakeholders in the process of discovering the sustainability goals that we are willing to embrace. With these priorities explicitly delineated, local resources are evaluated, including opportunities presented by the site itself, and recyclable materials and components that are locally available. Next, the functional requirements of the building are reviewed to see if it is possible to reduce the demand from that standpoint. Then building loads are reduced, first through efficient envelope design, solar and efficient lighting integration and then through energy distribution system design. The consideration of the health impacts of materials choices, daylight and energy efficient lighting and fresh air systems should take place next. Next, high efficiency equipment is selected with understanding of the reduced end loads. Finally, renewable energy generation is sized and integrated to provide on-site energy Throughout the process and during the future use of the building, continuous efforts must be made to reduce waste, improve health, use economical recycled and environmentally benign materials, and reduce the generation of pollutants.

Establishing consensus on green- building priorities is vital to a design procedure where tradeoffs will inevitably be made. One of the key lessons that emerged from the workshop is an understanding of sustainability as central to supporting the operation and the success of the participating organizations as successful philanthropic businesses. These priorities emphasize the energy and environmental issues in an area where initial costs commonly dominate decisions. In contrast, TSNE has continually compared the new design to a base case standard building, basing evaluation of improvements on the priorities established by the group.

Cost effectiveness is determined using life-cycle economics. This helps decide whether a technology or energy improvement is appropriate for the building. The economic analyses look for a 10-year positive cash flow using an 8% discount rate and 1% per year energy escalation. Local utilities provide the source of costs for electricity, heat, and water. Since the project is starting with an existing building, the base- case costs will be available, and we have extracted the individual costs for gas, water and electricity from them, and used these to calibrate the computer models for energy and cost savings.

It is recognized that we need to envision sustainability from the top down: from global level to the personal. From that viewpoint, the health of the biosphere is the limiting factor for sustainability. Envisioning the impact at this scale implies a long-term view. The building should reflect the responsibility we have for protecting the environment, the need to take the long view, not the high-tech, current tech view. We need to assess the impacts of the building and occupants, respect the natural limits, and demonstrate how to live within them

Applying Green Building Priorities to the Lincoln Plaza Building

The recognition that Sustainable design was a paramount priority for the project led to some immediate changes in the project. The initial choice of building was directly affected by the goals to maximize natural light and ventilation. After purchasing the Lincoln Plaza property, Third Sector embarked on a process to choose a new Architectural and engineering team with a greater understanding and commitment to the goals of green building and sustainable redesign. Third Sector New England, prospective tenants, and other interested parties collectively established a system for ranking economic, environmental, and sustainability issues related to the building. This process was facilitated and organized by the Hickory Consortium, specialists in Sustainable design and construction process. The results were used to select a new architectural team, inform the architecture and the stakeholders of the process and priorities for the designers, and serve as an educational model for green design. To that end, the firm of Symmes Maini & McKee Associates was selected for A&E services.

SMMA's work in sustainable design builds on the firm's 50-year history of creating truly integrated design solutions. SMMA’s approach, staff, and tools support the business goals of all clients, including those who aspire to obtaining LEED certification. SMMA's LEED-accredited staff includes recognized experts, active in the industry, writing articles, presenting papers, and lecturing on sustainability issues and trends.

SMMA approached this project as a whole, from site plan to interior fit-up, providing information and alternative solutions for achieving efficiency and energy savings, through such sustainable design practices such as environmentally friendly material selection, improved recycling programs, sustainable site design, and improved indoor air quality - both in the design and the construction phases.

Initially, SMMA began the process by taking known information about the building, evaluating existing conditions and analyzing the building structure and design and working toward an initial goal of establishing an immediate plan for separation of the residential part of the rehabbed building from TSNE's portion, which will be primarily offices and meeting spaces. SMMA developed CAD drawings to work from, based on incomplete older drawings from the 1985 renovation. Programming interviews with occupants began immediately.

Selection of general contractor:

In a sustainable building project, especially one that must be produced on a fast track, it is essential to have the builder on board from the earliest possible time. Feedback from the general contractor is essential for pricing and making choices of sustainable materials, techniques, and practices. TSNE's selection of the general contractor was undertaken with the help of Jennifer Pinck, Hickory and SMMA. Commodore builders - although a relatively new firm - was selected because of the extensive experience the company's principals bring to this type of project, and their eagerness to participate in a sustainable building project that is working toward LEED certification.

Design Charrette

At the outset of the TSNE offices project, the Design Team conducted a Green Charrette and workshops with the client and team of consultants to assess the level of sustainable "green" practices that responded to the client's program and the feasibility of a LEEDTM certification. The one-day Green Charrette reinforced sustainable goals discussed earlier in the process. Those goals were then implemented in the design decisions and construction documents."

The design charrette was one of the first events marking the beginning of the serious work to plan the new spaces. At this event, TSNE staff, tenants, and potential tenants met with design architects and engineers, sustainability and space planning consultants.

The purpose of the charrette was to begin the design process for the rehab of the interior spaces, while eliciting the goals of the individual tenants, and informing all of the sustainability issues for the project. A summary of the charrette results is shown in Appendix A.

The charrette began with a review of the decisions made at the previous sustainability workshops and the resulting priorities for the project. Mark Kelley, of the Hickory

Consortium, discussed these priorities and the opportunities for sustainable design for the building based on preliminary energy analysis.

After the introduction to the project, the attendees split up into several groups focusing on different aspects of the design. These groups included space planning, interior materials, and energy issues.

A major goal that resulted from the charrette is to reuse much of the existing construction, materials and systems as possible. Efforts to reuse and recycle the ceiling tiles, wall systems, furniture, doors, server cabinets, racks and other components in the existing building have been a significant part of the reconstruction.

A plan for recycling areas on each floor has been implemented and a building-wide recycling program has been initiated. The builder prepared and implemented a waste disposal plan for construction and demolition waste recycling.

The group reached the consensus to use new carpeting (carpet tile preferred) with high recycled content, low VOC and to recycle all existing carpet that is removed. TSNE is willing to pay extra for linoleum – preferring linoleum tiles in a pattern for all kitchen, copy and break room areas. In addition, some demountable partitions are being salvaged and moved to other floors.

Design:
The design process following the charrette strove to accommodate as many of the consensus issues as possible within the context of a building that had physical space constraints, and budget constraints.

Materials and Resources: The following is a list of the initiatives and efforts undertaken by the Design Team, including the owner, to maximize a sustainable approach to the Materials and Resources opportunities for this project. These initiatives contribute to multiple LEED credits as part of the LEED-CI certification. Also included are comments related to the lessons learned from the process.

? **Building re-use**
Re-use of an existing Downtown Building.
Since many of the spaces are in nearly usable condition, the primary design goal was organization and design for interior fit-up. The re-use of core areas was possible with minimal redesign. Existing operable windows filled two of the key goals of the sustainability scoping session, daylight and operable windows for ventilation and contact with the outdoors. It was possible to re-use these operable windows.

? **Resource re-use was successful for the following components:**
1. Existing doors re-used (from adjacent Cresset building)
2. Existing door hardware
3. Existing casework, counters, shelves.
4. Existing furniture (partial – future phase renovations)

5. Existing Clestra wall partitions located on the second floor were originally planned for a conference center on that floor. Because of various long-range revenue decisions, we changed the design so that the conference rooms will now be on the first and second floors, making the Clestra walls usable only on the 2nd floor. The potential results are the loss of a LEED-CI credit, or seek to move the balance of the Clestra partitions to other floors. The relocating of these partitions may prove to be very costly.
6. Existing light fixtures, exit light, sprinklers heads, etc.
7. Existing cable tray
8. Existing data server furniture

? **Construction and demolition recycling - waste management**
With a clear goal and plan for construction waste management, we are nearly reaching a 75% goal of diverted waste from landfill. This required superior collaboration from the Contractor.

? **Rapidly renewable materials**
Linoleum is used for the common break areas and copy rooms

? **High Recycled content materials**
1. Ceiling tile and grid
2. Metal studs
3. Gypsum Wall Board
4. Carpet
5. Rubber base
6. New systems furniture

? **Storage and collection of recyclables has been designed for each floor in the core area. Recyclables are to be collected in the basement-recycling center.**

? **Owners have embraced an environmentally preferable purchase program**

? **Indoor environmental Quality impact from materials' selection**:
1. Use of No-VOC paints
2. Use of Low-VOC carpets
3. Use of Linoleum flooring for the common break areas and copy rooms
4. GreenGuard Certified Systems furniture (partial)

? **Other benefits linked to materials**
1. Potential Green House keeping program, which involves using housekeeping cleaning products that have low VOC content and contain less harmful chemicals. These have shown to further accentuate better indoor air quality in buildings.
2. Indoor chemical & Pollutant source control (not on every floor)

LEED –CI Certification Progress
The LEED-CI (Commercial Interiors), process is brand new. This building is one of the first to attempt to qualify under the Commercial Interiors LEED system. Third Sector

New England has a strong commitment to sustainable design and a design team with a similar dedication to sustainable building. The challenges are serious, however due to a building that requires little rehabilitation, a fast track construction schedule, and a typically tight budget. We have struggled with reuse of materials and components, water saving appliances, and furnishings, finishes and adhesives. Similarly, initial good intent to protect 90% of daylight and views on the seventh floor was scuttled by the choice to have many exterior, closed offices, and by reducing costs by limiting transom and sidelight glass. However, we did install sidelights in some offices, and will recalculate with the hope of reaching 75% level for daylight and views.

To qualify for LEED-CI, a minimum of 20 points out of a possible 57 must be achieved. Many of these points are not attainable because of the site and condition of the building. For example, water efficient landscaping is not applicable because there is virtually no landscape in this urban building. Because water source heat pumps are in place and the system is being upgraded, there is no opportunity to change to non-CFC refrigerants, since manufacturers do not yet make this equipment without R-22. The building is not on a brown fields site, and reduction of light pollution is not feasible because there are currently no outdoor lights except in the courtyard, and these are at the bottom of a seven story well and are rarely used. There are no parking lots to reduce heat islands, and since the bathroom fixtures are generally not in need of replacement, the opportunity to obtain a point would be cost prohibitive.

Nevertheless, a great deal has been accomplished. The urban site, near South Station, has transportation points and development density sewed up; not having parking spaces gets a point as well, and adding showers and bike racks improves the LEED score in transportation. In terms of optimizing energy performance, the lighting power reduction to 0.9 watts/sq. ft. significantly exceeds the ASHRAE 90.1-99 standard and qualifies for NSTAR incentives. Current modeling indicates a 31.5% energy savings relative to that standard, and the potential for using renewable energy for combined heat and power will garner points for renewable energy, and very likely a design innovation point, since the proposed system is the first of its kind.

Additional points for ventilation effectiveness and additional commissioning appear to be within reach as are points for sub-metering and tenant allocated energy costs. Due to great cooperation and knowledge on the part of the building contractor, there will be points for waste management, recycling of materials (possibly 2 points for 75%) and construction IAQ. We unfortunately could not get the point for composite materials because of reuse of existing particleboard and other building components such as countertops in kitchens. Similarly, since control of the tenant's furniture is difficult, the low emitting furniture and furnishings point may prove elusive. However, we do expect to achieve credit for many indoor environment and materials points.

The most up-to-date LEED checklist and score are shown in Appendix C. Currently we are certain of 14 points, providing the renewable energy production system is pursued, and it appears likely that several other points are within reach. The final count is pending on phase 2 of the tenant construction. Perhaps just as important, on several sustainability vectors we are greatly exceeding the LEED requirements, including IAQ and Energy conservation. There is little doubt that this building deserves its green credentials.

Lessons Learned: Though many goals have been achieved, some of the early sustainable goals established at the green charrette have been reversed. The following lessons learned show the impact on LEED-CI certification.

1. On the TSNE floor, with the layout of the plan, we maximized day lighting and views by having mostly open perimeter offices, and by installing full glass paneled doors on all inside offices, including the 4 perimeter offices.
2. On the multi-tenant floor, tenants did not fully maximize the proposed layout for open perimeter offices and preferred offices on the perimeter walls – some of these were existing offices, and where new offices were built, we installed sidelights to increase daylight in the interior space. This approach has negatively impacted the LEED-CI credit to achieve the 90% daylight and views of occupied areas.
3. Although we planned to re-use existing ceiling tiles, adding extra tiles as needed from the portion of Lincoln Plaza that is being converted to condominiums; we were not able to achieve this goal on the seventh floor because of too many mismatched tiles. The fourth floor has recycled tiles on some, if not all ceilings. Where tiles could not be reused, existing tiles were recycled through the tile manufacturer's program (C & D recycling),
4. Planning changes for the phase 2 – 2nd floor renovation may be conflicting with maximizing the approach of the building re-use. The LEED-CI building re-use credit for the Clestra walls, met through earlier planning approach, is now in question.
5. At the outset of the project, a set of building materials and finishes standards were planned for the building tenants. The standards have incorporated sustainable design criteria.

Energy and mechanical systems

The HVAC system for the building was actually much better than the average system of its day when it was installed in 1985. The water source heat pump system can provide heating and cooling simultaneously to different zones and recover the heat or coolness from one zone to use elsewhere in the building. Though efficiencies of these systems are not as high as often claimed, they have comfort advantages and make the most of temperature differentials in buildings with east and west glass driving cooling loads. The heat pumps are serviced by two large steam boilers in the basement, and two closed circuit cooling towers on the roof. In addition to the heat pumps, there is a rooftop heat recovery ventilator with a heat wheel. Preheated ventilation air is delivered to each floor and most zones by supplying air to the plenum area above the ceiling.

Before the building was purchased, a due diligence report showed that there were a number of deficiencies in the mechanical systems, and that the water source heat pump system is near the end of its useful life. Furthermore, the rooftop cooling towers were not operating at capacity due to broken fan motors and failing cells. The boiler system also was of poor efficiency, since it is a converted steam system, using heat exchangers to convert steam into lukewarm water for the heat pumps.

More recently, engineers from SMMA have done a more detailed evaluation of the HVAC systems within the building, with consideration of the new configuration of spaces and resulting reduced loads. Confirming the findings of the due diligence study, SMMA found that most of the heat pumps need replacing, and the cooling towers are not working to capacity, with risk of failure high. The boiler system in the basement is old but durable – consisting of ancient steam boilers converted to hot water production. The efficiency of the conversion is low, however, and it is estimated that the overall system may be lower than 60% efficiency. In addition, both the boilers and the cooling system are significantly oversized for the building, even more so for the reduced building size of the TSNE space. It is estimated that the heating generation system could be reduced by over 50% and the cooling system by 70% without jeopardizing comfort in the building.

SMMA reviewed the control systems and pumping systems, finding that the system controls are inoperative; most systems have been manually controlled or not controlled relative to efficient operation. These factors contribute to the high cost of HVAC and electricity in the building.

The Hickory Consortium developed a DOE2 model of the building, first to evaluate envelope and system opportunities, and second to estimate the savings potential for HVAC improvements. It will also be used for final estimation of energy savings for LEED certification. Energy savings for lighting conservation, day-lighting, variable speed drives for pumping, energy star office equipment and reduced infiltration were evaluated. After SMMA evaluated the building and suggested three possible HVAC improvement packages, the DOE2 model was used to estimate the potential savings from each package.

The HVAC options packages are included in Appendix C. An overview of the recommended package is as follows: 1. Replace the steam boilers with three high efficiency water boilers. 2. Replace the condenser and hot water circulating pumps with variable speed, high efficiency pumps. 3. Service and repair the heat recovery unit and add a hot water heating coil to allow delivery of ventilation air at all times. 4. Replace the existing cooling tower. Upgrade lighting in lobby and core spaces (day-lighting and high efficiency lighting in tenant spaces are part of each tenant's fitout plan). 5. Install DDC control system for HVAC, etc. to provide start, stop, scheduling, alarm and status for systems. 6. Replace hot water heater (recommended by Hickory: 500 gallon indirect fired storage tank rather than new water heater).

DOE2 Results for LEED Energy Performance
The DOE2 modeling used for evaluation of energy options throughout the design process can also be used for LEED energy performance and certification. Energy savings from lighting and day lighting, equipment, controls, ventilation, pumps and fans, new boilers, cooling towers, and renewable generation can be modeled. The results show considerable energy savings from the package of measures selected for installation.

For LEED purposes, the base case must be changed to reflect the ASHRAE 90.1-99 standard, which is stricter in some ways than the Massachusetts Code. However, that standard is actually much better than the existing building, which has inoperative controls and low efficiency (1985 vintage) equipment less ventilation, and higher lighting power than currently allowed by code or by the ASHRAE 99 standard. The savings calculated are therefore less than the actual savings because they are compared to a theoretically high efficiency building that meets the new standards rather than the actual existing buildings. Even so, the savings are significant, and represent what would be saved in comparison to a theoretical ASHRAE 99 building.

Due to the installed new equipment and controls, energy is saved relative to the base case in all categories of electric use as well as fuel use. Part of the savings is due to the provision of renewably generated electricity. The DOE2 software allows the application of cogeneration equipment, and it can accommodate the specific characteristics of the STM sterling engine combined heat and power system. Unfortunately, one drawback is that the recovered heat can only be applied to the space heat system, not to the domestic hot water. Therefore, the electric generation and the value of the recovered heat are lower in the DOE2 estimate than in the spreadsheet life cycle cost analysis in the following section. Nevertheless, without adjusting for the probable higher CHP renewable energy generation, the DOE2 LEED results show a savings of 31.76% relative to the base case.

Third Sector New England DOE2 LEED Modeling Results

Energy Summary By End Use

End Use	Energy Type	Proposed Building Energy (MBtu/yr)	Proposed Building Peak (kBtu/h)	Budget Building Energy (MBtu/yr)	Budget Building Peak (kBtu/h)	Proposed / Budget Energy (%)
Lighting - interior	Electricity	861.9	357.3	1511.4	480.6	57%
Lighting - exterior	Elec-unregulated	0	0	0	0	n.a.
Space heating (1)	Electricity	1239.8	1731.1	2111.4	2444.4	59%
Space heating (2)	Fuel	9990	2191	16103	3697	62%
Space cooling	Electricity	1094.5	1540.6	1657.7	1990.5	66%
Pumps	Electricity	257.9	86.3	1221.3	185	21%
Heat Rejection	Electricity	0	0	0	0	n.a.
Fans	Electricity	1032.7	271	1532.2	330	67%
Service water heating	Fuel	8412	319	15382	583	55%
Misc Equipment	Elec-unregulated	644.7	240.3	872	277.1	74%
Total Building Consumption		23533.5		40391		58%

Regulated Energy Use and Cost Summary By Fuel Type

	Proposed Building Energy (MBtu/yr)	Proposed Building Cost ($/yr)	Budget Building Energy (MBtu/yr)	Budget Building Cost ($/yr)	Proposed / Budget Energy (%)	Proposed / Budget Cost (%)
Electricity	4486.8	$ 271,063.00	8034	$ 400,357.00	56%	67.70%
Fuel	18402	$ 50,216.00	31485	$ 47,512.00	58%	105.70%
Other fossil fuel						
District steam						
Total nonsolar	22888.8	$ 321,279.00	39519	$ 447,869.00	58%	71.70%
Renewable Fuel		$ 22,329.00				
Solar or site recovered		$ 37,979.00				
Total including Solar		$ 305,629.00		$ 447,869.00		
				LEED Savings %		31.76%

Renewable technologies

Building Design Opportunities for Renewable Energy Generation:

Located in the downtown Boston area known as the Leather District, the Lincoln Plaza building is near South Station and several other high-rise buildings. Though the East side currently has solar access, this will be short lived, since there are plans to build a new building at that location. This also jeopardizes the potential for using the roof for photovoltaics, as shading is possible in the future. Wind power likewise is subject to wind shadowing and vibration issues, and is therefore not a viable technology for this location. Renewable strategies are therefore restricted to renewable fuel systems, which may be a good match for the power loads in this building. Biofuels, such as biodiesel, waste oil, ethanol, and hydrogen and wood chips are possibilities. Since the Hickory Consortium has been active in the Biodiesel combined heat and power field, this is the area that was selected for preliminary consideration.

Combined heat and power (CHP) systems provide both electricity and heat for application to hot water and space heat creation. As such, they provide on site or distributed power sources, reducing the need for central power plants and infrastructure, even though CHP systems typically use fossil fuels. A very promising application for this technology is in the use of renewable resources instead of fossil fuels. With fuel costs steadily climbing and greater numbers of consumers interested in renewable resources, the buildings sector is ripe for this application. In addition, new equipment, which can facilitate this use, is rapidly entering the market.

Biodiesel is an agriculturally derived fuel oil made by combining any natural oil with methanol or ethanol resulting in a renewable source of energy with great portability that dramatically reduces pollution generation in comparison to petroleum based fuels. Waste oil is the byproduct of restaurant cooking and is made of soybean or other plant based oil without combination with an alcohol.

Renewable fuel, particularly Biodeisel fuel, is available in the Boston market, and increasingly will be derived from both farm products and waste cooking oil. Biodeisel can directly replace diesel in most engines with little modification and greatly reduced pollution. Equipment that provides both electrical generation and heat for domestic hot water is available in a size range that is appropriate for this building.

New technologies as described herein promise to make biodiesel and waste oil combined heat and power systems available and efficient for small-scale commercial and multifamily applications. At the forefront are the use of Sterling engines with external combustion and few moving parts, which are now entering the market. These quiet, small engines can be easily modified or used "as is" for combined heating and electricity generation.

Currently, there is not a large selection of equipment for combined heat and power that would be appropriately sized for Lincoln Plaza and adaptable to renewable fuels. The

STM sterling engine is appropriately sized, runs on liquid fuel, and has manageable maintenance requirements.

The fuel of choice appears to be biodiesel fuel available from World Energy in Chelsea now available at $2.669 /gallon- for powering a diesel prime mover, sterling engine, or microturbine. Waste oil is far better in cost; at as little as $0.12 per gallon and approximately the same energy value per gallon, but this can only be used in external combustion equipment that can handle dirty fuels efficiently.

State of the Art Solution:
Though standard internal combustion diesel engines can be effectively used for combined heat and power, and we have applied one to an apartment building, there are some significant drawbacks. The use of standard diesel engines with biodiesel has been well established for perhaps half a century in farm applications, and many CHP systems have been installed using fossil diesel, no track record of biodiesel and CHP has been established. Consequently, because manufacturers have much more experience with petroleum fuels, at present, none will warranty these new applications. Other issues include excessive noise, size limitations, high maintenance costs, poor response to frequent starting, and replacement after as little as 10-15 years, resulting in limited use in commercial applications.

Several new technologies promise to bring solutions to all of these problems. Micro turbines are available, and were the original choice for Hickory's current projects, because these small engines and can meet commercial needs, but there are few manufacturers, and those that exist are still leery of the new fuel option. More promising is external combustion Sterling engines which are just entering the market and promise quiet, efficient operation. They have minimal moving parts, hence fewer repair and maintenance issues and greater longevity. They are easily adapted to alternative fuels and are available in small sizes appropriate for single family buildings with energy loads as small as 0.8 kWe and a resultant 3000 – 4000 BTU/hr of heat which is well matched to hot water loads. Larger versions from 55-75 kWe, can produce sufficient power and heat for commercial buildings, multifamily or small community situations.

The value of using biodiesel or waste oil in this type of application is very high, in that it offers the choice of a renewable resource with an efficient, on-site or distributed power source technology. Taking a deliberate step toward its realization is important for future projects and for expanding the use of this renewable resource. Biodiesel has been used extensively in transportation applications with standard internal combustion diesels with no reported problems, but most applications use a 20% biofuel mixed with petroleum diesel (B20). Converting this technology into use in a stationary medium such as commercial buildings offers a number of additional advantages including the use at room temperature, which permits the use of 100% biodiesel fuel (B100) without concern for waxing or solidification at low temperatures. This is important, since there will be no climatic or environmental obstacles as with a mobile medium such as a bus. Biodiesel in CHP systems also shows great promise in pollution reduction and quiet operation, also appealing to the commercial market.

Current and developing technologies range in output from under 1 to 75 kW. STM power produces an external combustion sterling engine, designed for on-site power and heat production. STM Power is also in the process of designing an all fuels burner for its 55 kW unit which is particularly exciting as it can result in a fuel cost of as little as 9 cents per gallon for waste oil. The external combustion feature allows the optimization of combustion for precise control of emissions, to minimize environmental impact.

Matching control strategies with building load profiles and utility rate structures for maximum economic efficiency is a crucial area of design inquiry. Utilities also need operational data to get an understanding of how these systems will impact their power production needs. There is a strong need for systems engineering to integrate this new equipment with buildings characteristics and energy uses. The opportunity offered by the Lincoln Plaza building, with a DDC control system for monitoring and control programming, is ideal for optimizing control configurations and monitoring the efficiency and utility impact.

Renewable System Configuration and Design for analysis

The operating characteristics of the STM machine are shown in figures 1 and 2. The Sterling engine has a relatively flat efficiency curve, so it can be operated at lower output with little sacrifice in efficiency. This allows some flexibility in operation at lower heat and electric loads.

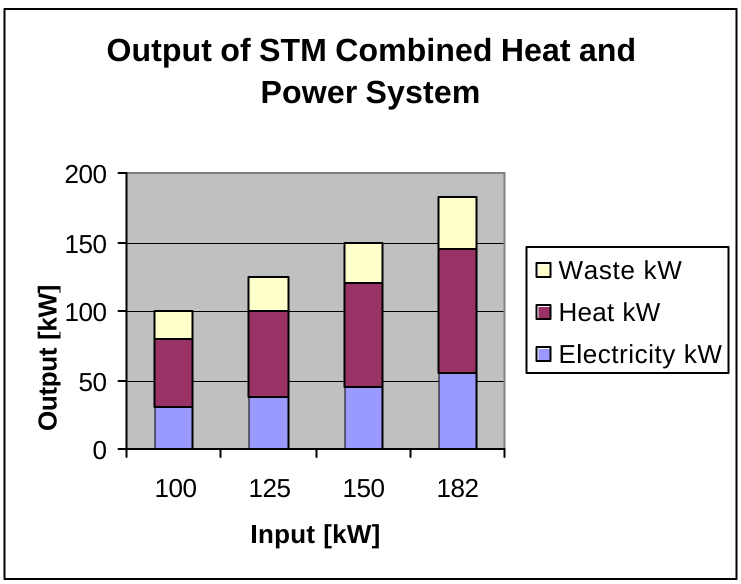

Figure 1

For the typical operation, however, Figure 2 indicates the disposition of the energy from the biodiesel fuel. At standard operating conditions, the input is 621,166 BTU/hr or approximately 4.5 gallons per hour. The output is 55 kWe and 91 kWth or 187,715 BTU/hr. Note that less than 20% of the energy in the fuel is wasted.

Biodiesel Fuel Input		
182	621,166 Btu/h	100.0%
Power Output		
55 kw-elec	187,715 Btu/h	30.2%
Recovered Heat		
91 kw-heat	310,583 Btu/h	50.0%
Rejected heat		
36	122,868 Btu/h	19.8%

Figure 2

The system under consideration is a combined heat and power system using a Sterling engine and heat recovery system, which captures 50% of the input energy as hot water. This hot water may be used for heating or domestic hot water supply. Because the domestic hot water need is year round and on average slightly greater than the output of the CHP system, domestic water heat will be the first order of preferential use. Excess heat will be used to supplement the heating system hot water needs.

Lincoln Plaza will need approximately 2,980,000 BTU/hr for heat at design conditions, and approximately 100,000 BTU/hr for Domestic Hot Water on a year round basis. The fuel use is estimated to be a minimum of 633 therms for July and a maximum of 3600 for January. The Peak electric usage is estimated at 800 kW and typical use would be of the order of 123,000 to 185,000 kW/month. The STM Engine has a full load power production of 55 kW and heat production of 91000 BTU/hr.

With the use of hot water storage, it is possible to control the system to produce electricity reliably on peak, while storing the recovered heat for use at other times. Hot water use is expected to be minimal during the daytime peak hours, but will be larger in the morning (for showers for exercising or bicycling workers) and in the evening for cleaning.

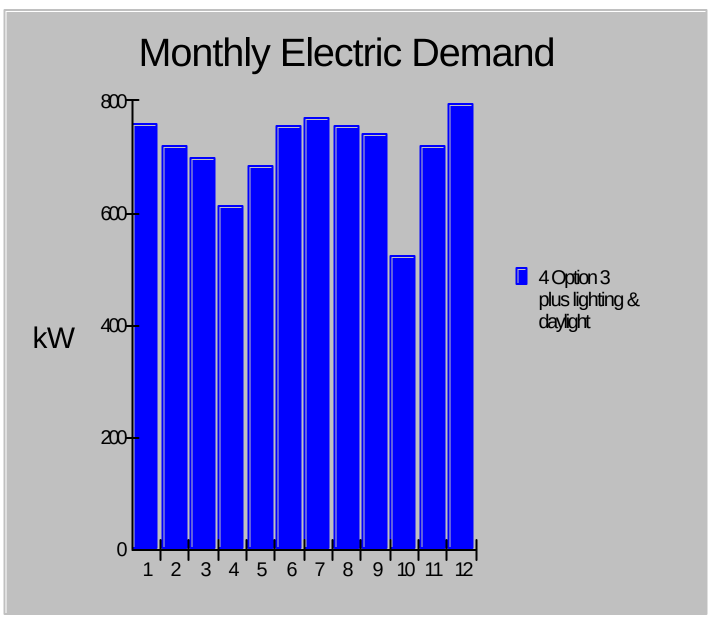

Figure 3

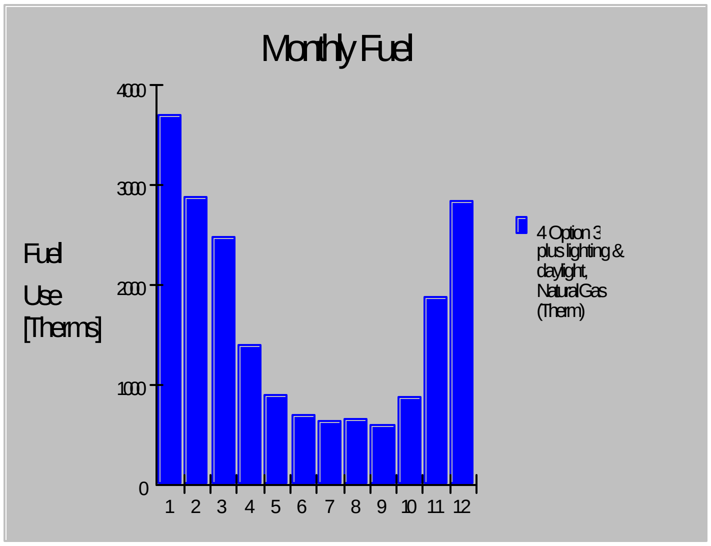

Figure 4

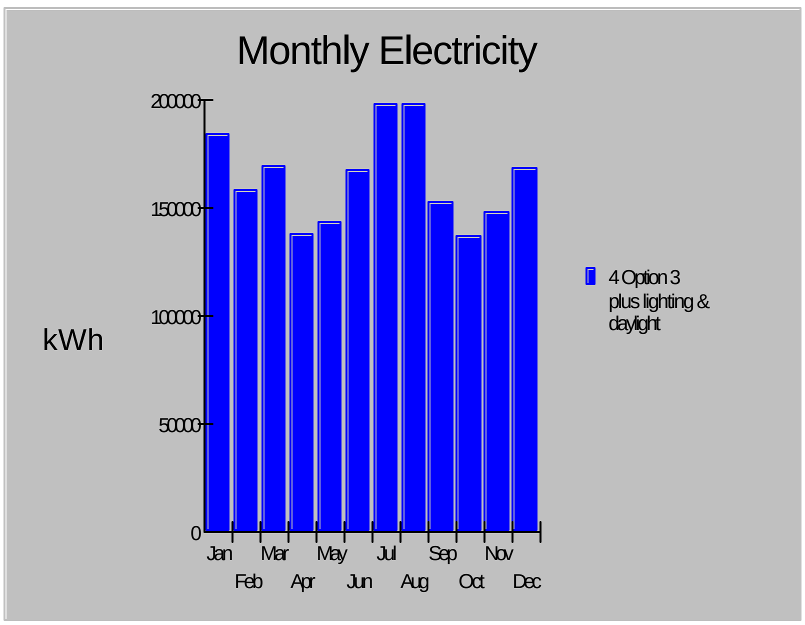

Figure 5

The ideal system configuration for this sterling engine would provide all of the domestic hot water, some of the electricity, and some of the heat for this building. Since the DHW load is year round, the heat energy will be prioritized for this end use. Having an indirect fired storage tank for domestic hot water makes the system integration easier and provides a capacitance, which lets the sterling engine run for long cycles. The system configuration we have analyzed includes a three hot water boilers and a 1000-gallon storage tank for domestic hot water. This will give us security of three high efficiency boilers, which will make up for any shortfall during cold weather.

Interconnection:
The safest way to provide baseline average demand power with rejected heat used by the building is to use "net metering" with power sold to/bought from the grid utility based on above or below baseline demand. Interconnection gear must satisfy the local utility-NSTAR of ability to sense a grid fault and disconnect. The interconnection and controls must be designed to meet the proposed IEEE 1547 standard for interconnections between distributed generating equipment and electric utility distribution lines. An added benefit to the commercial owners will be automatic standby hot water and heat. Air conditioning technology might be adopted that would allow rejected heat use in an absorption cycle chiller to provide AC as well.

NSTAR is currently working out rules for physical interconnection for this type of equipment. There are issues related to the type of grid sensing cutoff systems to provide safety for linemen. Unlike inverter-based equipment, rotating equipment has special safety needs. It is expected that details for this equipment will be settled within a few months.

Fuel-Storage-requirements: The CHPS will use approximately 3-4 gallons per hour on a continuous basis, or about 85 gallons of fuel per day. Storage needs for a minimum of 2000 gallons are necessary to provide capacity to buy fuel at lower costs. A previous oil based system had a large storage tank adjacent to the boiler room, which has since been removed, but that would be an ideal location for a new biodiesel or oil storage tank or an array of six 330-gallon tanks for 20 week's supply on hand. A day tank and transfer pump system will also be required.

Heat Reclamation Equipment: an integral jacket hot water heat reclamation system is an integral part of the STM packaged system. The heat from this system will be exchanged first to the domestic hot water and then to the heating load. It may also be cost effective to reclaim heat from the exhaust gasses.

Emissions: The STM Sterling engine is an ultra low emissions generator when using standard diesel fuel. Because it is an external combustion device, the combustion can be more carefully controlled with respect to emissions, particularly oxides of nitrogen. With Biodeisel, the emissions will be dramatically reduced. The table below shows reductions in major pollutants as a result of switching from standard diesel to biodeisel. As noted, the NOx savings will be positive with this equipment.

Table 1 Reduction of emissions compared to petroleum diesel

Pollutant	% Reduction
CO_2	78
CO	48
NO_X	-10↴ +35
SO_X	99
Unburned Hydrocarbons	67
Particulates	47
Carcinogens	48↴ 93

Biodiesel has a lower energy density than petroleum diesel (123,000 vs. 140,000 Btu/gal). Biodiesel also has more oxygen (10–12% by weight) and a slightly higher cetane number than petroleum diesel. Most biodiesel today is mixed with petroleum diesel. The most common mixture is B20, a mix of 20% biodiesel and 80% petroleum diesel. B100, or 100% biodiesel is being used very successfully by some but is not as widely recommended or used, due to concerns about cold-weather performance, which in this case is not a concern, since the equipment will be indoors. Biodiesel is cleaner than petroleum diesel, results in far lower greenhouse gas emissions, is biodegradable, and therefore is not a spill hazard.

Surprisingly, biodeisel results in significant reductions in greenhouse gas emissions. While combustion of any fuel releases carbon dioxide into the atmosphere, the biofuel cycle is different from the fossil fuel cycle. Growing the agricultural crop used in that fuel captures a similar amount of CO_2 through the process of photosynthesis. In addition, a DOE/USDA lifecycle study found the net CO_2 emission from petroleum diesel to be 633 grams of CO_2 per brake-horsepower hour (g/bhp-h), while the net CO_2 emissions for B100 biodiesel are 136 g/bhp-h, a 78% reduction.

6. Economic Analysis:

The detailed table below presents the operating characteristics of the proposed STM Combined heat and power system. Three cases have been shown: The first is the unvarnished case with no incentives of any kind. The second is Biodiesel fuel, MRET initial cost incentives and Renewable energy certificates. The third shows the economics using waste oil, which has a very low price: $0.12 per gallon.

Table 1

Economics for the TSNE Biodeisel Project

Equipment Operating Characteristics

Power Output			
	55 kw-elec	187,715	btuh
Recovered Heat			
	91 kw-heat	310,583	btuh
Rejected heat			
	36	122,868	Btu/h
Fuel Input			
	182	621,166	Btu/h

Installed Cost for Renewable Combined Heat and Power System	**No Incentives**	**Cost estimates with renewable incentives**	**Renewable and waste oil fuel**
STM Engine	$40,000	$40,000	$40,000
Heat Recovery Units, switchgear, controls	$15,000	$15,000	$15,000
Mechanical Design	$20,000	$20,000	$20,000

Shipping/Installation/interfacing/DHW Storage	$45,000	$45,000	$45,000	
Contingency/engineering/approvals	$4,500	$4,500	$4,500	
MRET Incentive	n/a	-$88,200	-$88,200	
Total Installed Cost	$124,500	$36,300	$36,300	
Annualized Initial Cost	$5928.57	$1,728.57	$1,728.57	
Owning & Operating costs				
Electricity Consumption savings				
100% available Generation per year	481,800	481,800	481,800	kwh
Availability	75.00%	75.00%	75.00%	
Yearly production	361,350	361,350	361,350	kwh
Marginal Electric Rate	0.134	0.134	0.134	cents/kwh
KW demand charge	15.84	11	11	$/kw
Monthly demand reduction	55	55	55	kw
Monthly demand charge reduction	$871	$605	$605	
Yearly demand charge reduction	$10,454	$7,260	$7,260	per year
Yearly consumption cost reduction	$48,421	$48,421	$48,421	per year
Yearly Electric cost avoided	**$58,875**	$55,681	$55,681	**per year**
Cost to produce electricity				
Cost to produce electricity				
BioDiesel Fuel Cost- World Energy	$3.128	$3.128	$0.120	gallon
Heating Value of BioDiesel Fuel	137,500	137,500	137,500	btu/gal
Energy used in GPH	4.52	4.52	4.52	GPH
Cost per hour for fuel	$14.13	$14.13	$0.54	$/hr
Cost per KWH	0.257	0.257	0.010	$/kwh
Annualized initial cost at 5%	$5,928.57	$1,728.57	$1,728.57	
Cost per year at availability shown	$92,840	$92,840	$3,562	per year
Reserve for operation and maintenance	$1,245	$1,245	$1,245	per year
Yearly Cost of Operation	$100,014	$95,814	$6,535	
Cost per kWH including maintenance	$0.2768	$0.2652	$0.0181	
Heat savings				
Heat Reclaimed per hour	310,583	310,583	310,583	btuh
Heat reclaimed per year	2,040,530,310	2,040,530,310	2,040,530,310	BTU
Heat reclaimed per year	20,405	20,405	20,405	therms
Alternative Natural Gas Heat				
Fuel Price-NG price per therm of gas	1.5	1.5	1.5	$/therm
Fuel Heating Value	100000	100000	100000	btu/therm
Boiler Efficiency	90%	90%	90%	
Cost per therm of heat produced	1.67	1.67	1.67	$/therm
Avoided Cost to produce heat & DHW	**$34,009**	$34,009	$34,009	**per year**
Summary Avoided costs				
Yearly Electric cost avoided	$58,875	$58,875	$58,875	**per year**
Annual Avoided Cost to produce heat	$34,009	$34,009	$34,009	**per year**
Total Annual Cost Avoided	$92,884	$92,884	$92,884	**per year**
Total Annual Cost of Owning & Operation	$100,014	$95,814	$6,535	**per year**
Renewable Energy Certificates	N/A	$18,068	$18,068	

Total Cost (SAVINGS)	$7,130	($11,943)	($101,222)	**per year**
Annual Life Cycle Cost savings	($7,130)	$11,943	$101,222	**per year**
Simple payback - Years	N/A	3.04	0.36	
IRR 5%discount	N/A	13%	86%	

Looking at Table 1, we see the initial cost of the proposed CHPS system is approximately $124,500. In addition, on an annual basis, the maintenance costs are assumed to be of the order of $1245 (1%) and the entire unit would be rebuilt after about 15 years of operation.

The initial cost for the system assumes that a larger than otherwise necessary hot water storage tank is installed. Using a thermal storage tank for domestic hot water will allow operation of the system on peak, and avoid the load following requirement that prevents demand savings. For example, if the showers are used first thing in the morning, the water in the storage tank may drop in temperature from 150 to 130, but the reheat of the tank can wait until mid afternoon when peak charges are in effect. Control strategies will need to be optimized to take advantage of this opportunity.

When an incentive supporting the initial cost of equipment and installation is included and the value of the Renewable Energy Certificates is added, the economics become very positive. A three-year payback and a 13% rate of return accrue even with the use of now expensive biodiesel fuel. If the system can use much lower cost waste oil as fuel, the economics become even more compelling, with a first-year payback and a whopping 86% return on investment. It should be noted, however, that at present, the supply of waste oil, though plentiful, is mostly recycled for other products, it is not generally handled in the same way as biodiesel, that is the biodiesel is supplied with regular oil tank trucks, but there is currently no similar commercial supplier of waste oil. It may be possible to make an arrangement for delivery with current recyclers of waste oil.

Though the prices for biodiesel fuel have increased by 64% in the past year due to demand and competitive fuel pricing, the existence of renewable energy certificates supports the CHP project and makes for a solid payback in the two cases that assume MRET Subsidies for the initial costs. Surprisingly, the non-subsidized case would also show a positive economic picture if renewable energy certificates were assumed. The added $18,068 for certificates would result in a positive annual cashflow of nearly $11000, and an 11.4-year payback and a 6% rate of return.

What makes a good investment for Third Sector New England? There are many measures used to evaluate investments such as the investment in power generating equipment. Simple payback is often used because it is easy to understand, but a more robust analysis results from a life cycle cost or internal rate of return analysis.

If the internal rate of return of the project is equal to or greater than the required rate of return of the organization (say 8%), then the project will likely be considered acceptable (assuming equal risk). If it is less than the required rate of return, or the risks are higher, the project is typically rejected. The big advantage of using the internal rate of return indicator to evaluate a project is that the outcome does not depend on a specific discount rate. Instead, the IRR obtained is specific to the project. The financial model uses the yearly cash flows and the project life to calculate the internal rate of return. Since we have chosen a long project life, the IRR of the investment is increased.

As a non-profit organization, no tax incentives are available, so an investment must pay for itself unsupported. There are varying estimates of what this advantage (the "attribute value"), based on what people are prepared to pay for premium renewably generated power. Estimates range from 5 cents to 10 cents extra for a kWh of renewably generated power. We estimated a value of 5 cents per kWh, since this is a currently available offer. For the amount of renewable electricity generated by this system, the Certificate value is $18068.00 per year.

The CHPS system produces both electricity and heat. If the cost of 100% biodeisel remains high ($3.128 per gallon, then the cost to produce electricity from this renewable source would be a high 26 cents per kWH, but this assumes all fuel costs are ascribed to electricity. This would offset standard electricity from the grid at approximately 13.5 cents per kWH. On the face of it, this would not appear to be a good price, but the fact that this is a heat and power-generating system makes all the difference. The value of the heat produced as a byproduct of electricity generation can be regarded as free heat or, better yet, combined with the cost of electricity to compare the combined costs to those of a standard system. Another way of looking at it is if we assume the electricity is worth the same price per kWH as grid power, the remaining cost goes for heat. The sum of the two costs is less than would be paid for both heat and electricity on an annual basis.

With Combined heat and power systems, we have the potential for approaching the goal of net annual zero energy. If this generation is powered by a renewable fuel source, we can make a positive impact on energy, security, and environment. For the Lincoln Plaza Building, the proposed system will meet only a fraction of the heat and electrical needs of the building, but the more important opportunity is to prove the concept of using biofuels in a sterling engine for combined heat and power.

Use of biofuels/biodiesel to provide electricity and heat for buildings has recently achieved a viable market potential. Maturing small-scale technology, fuel prices, utility interconnection experience, and political readiness are all aligned. Of particular interest at this time are the new sterling engine products entering the market. These small, quiet, external combustion engines can be designed to burn biodiesel and even waste oil, as STM Power intends. The advantages over internal combustion diesel and microturbines for building applications are numerous, but fuel adaptability, availability in .8 kW to 75 kW outputs, dispatchability, durability, and low noise are salient.

Commercializing sterling CHPs in buildings depends on integrating many threads: technical, political, regulatory, financial, and commercial. Though several sterling CHP products are on the market, most are gas based and there is virtually no buildings application experience. According to the USDOE's CHP Technology Roadmap, the greatest needs are raising awareness, removing regulatory barriers, and developing markets and technologies. For commercial CHP with biofuels, technology need includes building integration, control strategies, utility interfacing, design templates, and validation through operating data.

It appears that the feasibility of the Sterling engine biodiesel/waste oil combined heat and power system is very promising. There are certainly obstacles to be overcome, from the completion of the development of STM's all fuels burner to acquiring supplies of waste oil fuel. Trials of the STM CHP Sterling engines are underway using palm oil in an industrial setting. The interfacing and installation issues now appear to be manageable, though contingencies have been included in cost estimates. Given the cooperation and enthusiasm shown by the owners toward green building, Third Sector New England's Non-Profit center would be a good test bed for the technology.

7. Conclusions

Lessons From the sustainable design process

1. In selecting a building and in evaluating a selected building for sustainable upgrade, the building should be modeled to discover where the energy is being used and where the greatest opportunities for savings exist. "Low-hanging fruit" should be incorporated in the baseline requirements. Creation of a base-case building will have positive effects on decisions made in the design process. This is standard procedure for Energy Star buildings. Knowing where energy is going helps select effective targets for conservation measures.

2. If significant rehabilitation will be done, survey the existing building for material salvage value and document the estimated quantities. Engage a demolition contractor who understands the issues. Develop a demolition plan that recovers the maximum useful material and sorts the recyclables for lower disposal costs. Look for opportunities to reuse some of the materials in the new building

3. In reusing an existing building, much attention should be paid to interior finishes, materials, and the cost tradeoffs between new and existing materials. One lesson that should be kept in mind is that as building materials reuse decreases, it becomes harder to reach recycled material, local material, and other percentages, which are based on total materials excluding reused materials.

4. Functionality should be the watchword for the architects. The owners must advise on what constitutes functionality for this project. Design choices that enhance the interaction of the occupant community are desirable. Flexibility of spaces, pedestrian friendliness, and shared resources are highly valued by the tenants. Increasing communication by sharing resources in one place such as shared conference spaces and informal meeting spaces, plus designing pedestrian flow to increase communication, are examples.

5. Since we are buying an existing building, we need to integrate our priorities in factors affecting the choice. Many factors can be changed or improved in an existing building, but the site itself is crucial. Since delighting, views, and operable windows are high on the list, the building must be sited to allow these functions.

6. Ventilation system review and upgrade should be an important goal for engineering in the rehabilitation of the building. The new system will improve the ventilation by connecting the fresh air supply to the return side of each heat pump system. This will greatly improve distribution to all zones compared to the original system, which simply dumped fresh air above the plenum. This improvement may qualify for a LEED point for ventilation based on the new ASHRAE 62-2001 Addendum N for ventilation effectiveness.

7. Lighting and appliances account for a large proportion of cooling load as well as the electricity cost, so any rehab design should include a program to replace low- efficiency lights. The redesign resulted in a reduction of lighting power levels to .9W/sf, qualifying for NSTAR incentives and dramatically reducing energy use. It may also be possible to include in lease documents or other agreements a requirement for tenants to preferentially buy Energy Star office equipment, which will have a beneficial affect on costs as well as cooling needs.

More work needs to be done in clarifying the sustainability education and demonstration vector. While the general goal is laudable, far too often, the enthusiasm brought to these issues results in buildings with excess complexity of systems and construction. Our goal should be to demonstrate sustainability subtly, responsibly and achievably. We should embrace simple systems and materials, try to achieve simplicity, and approach the goals sensibly. Technologies included should be replicable and cost-effective. This is really worthwhile as a demonstration to the public and those considering buying and rehabbing buildings.

Lessons from the fast track construction process.

The short schedule made it quite challenging to achieve the LEEDTM certification process. The project was approved to be registered in the construction document phase. There was considerable effort expended to choose the specific LEED building category, whether "Existing Building" or "Interiors" Fortunately, most of the critical sustainable design criteria were already part of the design.

TSNE, as well as some of the consultants, including the general contractor, were not fully up to speed with LEEDTM and its process. SMMA and Hickory Consortium managed to integrate sustainable design and LEEDTM education throughout the project phases. The general contractor has caught up to the LEEDTM requirements for the project and has been very cooperative.

Although the original plan was to try for 90% of the spaces with daylight and views, this proved to be too great a challenge, since nearly all of the tenants wanted closed offices on the perimeter, and addition of inner wall glazing proved to be too costly except where recycled glass was used.

Water conservation technologies were difficult to include because there was no compelling reason to rehab the existing bathrooms. However, the new showers will have water-conserving fixtures. Also, automatic shutoff faucets have been added in the existing bathrooms.

- The bidding process was advanced to meet the schedule. It presented a risk to the team, but currently, most issues have been resolved through the shop drawings submittal process.

- Good communication and close monitoring of the decision and construction process allowed to overcome some of the impediments the team faced.

Throughout the process and during the future use of the building, continuous efforts must be made to reduce waste, improve health, use economical recycled and environmentally-benign materials, maintain systems and components and reduce the generation of pollutants. To that end, a building operations plan should be developed, which includes maintenance, equipment operation, cleaning etc. Copies should be available to tenants, owners, and maintenance workers as well as a supervision plan and they should be updated over time.

Recommendations

The design and construction processes have on the whole been smooth, with very good planning, including the initial prioritization.

Because of the fast track project schedule, lots of attention is necessary at the point of submission of material and equipment proposals by subcontractors. In the initial phase, heat pumps were installed without the necessary control valves, and the available water source heat pump equipment was not set up for the planned DDC controls. Similarly, scrutiny of proposed cooling tower systems revealed that the significantly lower cost of one submission was due to selecting the wrong capacity. Had the lower bid been accepted, the error might not have been caught until extremely costly changes were needed.

The design team should press for opportunities to educate the tenants on the importance of the sustainable design goals of this project, and how the plan layout plays a role in reaching them. It might have helped them approach the perimeter open office plan in a different view. It is recommended that prospective tenant documents and fit out planning documents include an explanation of the goals and reasons for enhancing daylight and views.

The presence of the commissioning agent on the job has provided a strong element of review of equipment in time to prevent significant problems. The commissioning agent has also been useful in providing documentation and review of potential LEED opportunities.

Though reuse of building materials and components appears to be an avenue for cost control, care must be taken in reviewing the condition and costs to reuse materials. In some cases the first costs can be more than buying new components and materials.

Appendix A: **GREEN CHARRETTE BRAINSTORMING DISCUSSION**

Item #	GREEN CHARETTE BRAINSTORMING DISCUSSION
1.01	"Green Charette" – collaborative, integrated, team (designers, users and builders) approach to sustainable design Establish decision making process for design and materials
1.02	Review goals established during TSNE's sustainability workshop 5 months ago with Hickory Consortium A. Sustainable Sites B. Energy & Atmosphere C. Comfort & Health D. Livability / Functionality E. Materials & Resources F. Water Efficiency G. Education
1.03	Sustainable site was chosen – reuse of an older building; soil will not be disturbed; project in a high density area; proximity to alternative transportation
1.04	Many opportunities to improve in terms of energy and atmosphere – delighting; more efficient equipment; use of renewable energy
1.05	Use LEED as a guideline to develop an environmentally healthy building
1.06	Decisions made during design can affect building operation – daylighting reduces absenteeism and makes people more productive; light sensors can result in utility cost savings of 30 – 50%; perimeter offices will limit daylighting
1.07	Existing tenant spaces will not be upgraded (except for building systems) until the tenants vacate
1.08	A major goal will be to reuse much of the existing construction, materials and systems
1.09	During the charrette we need to find out what is important to users and to make decisions on what will make the space successful to them
1.10	Group leaders in the charrette will have information to help teams make informed decisions
1.11	Design and layout of TSNE's space will not happen during the charrette
1.12	Cost shouldn't be a major factor in decision making during the charrette.
1.13	Goal of charrette is to rank TSNE's priorities clearly so that when we get the budget we can incorporate as much as possible of what is desired most

Item #	GREEN CHARETTE DISCUSSION
2.01	Existing conditions will not always be as they seem – a 9-story building is planned and permitted for the parking lot across South Street
2.02	LEED credit for reuse of interiors can be taken when at least 75% of the interior construction, including finishes, is maintained
2.03	LEED system will be used as a metric to set the bar for sustainable design goals
	MATERIALS AND RESOURCES – REUSE AND RECYCLING DISCUSSION
2.04	Neither the existing furniture in TSNE's office or at Lincoln Plaza is desirable for the new TSNE space
2.05	There are some miscellaneous furniture pieces from TSNE that can be reused (mail center, desks, conference tables, and chairs, etc.)
2.06	The furniture at Lincoln Plaza should be stored and made available to non-profit tenants
2.07	Priority of new furniture should be that it is ergonomic
2.08	TSNE will reuse all of the existing Lincoln Plaza tech furniture (server cabinets, racks, etc.)
2.09	Reuse CAT5 cable wherever possible
2.10	Reuse existing electrical and data outlets – prefer to extend from existing rather than moving
2.11	We can plan recycling areas on each floor, but a building-wide recycling program will need to be established
2.12	A hazmat disposal program will be needed for light bulbs and computer parts
2.13	TSNE would like to establish a computer recycling program for all tenants to participate in
2.14	Encourage tenants to use duplexing units (allowing for double sided printing) and provide duplexing unit(s) in the common print shop
2.15	Establish an environmentally friendly purchasing program and offer the information to tenants for their own purchasing programs
2.16	Reuse wood doors on 7th floor and refinish them as needed
2.17	Use a mix of exposed structure over open areas (like 2nd floor) with ceilings (as high as possible)
2.18	Reuse ceilings, especially soffits at conference room
2.19	Reuse interior glazing systems from 2nd and 7th floors as fronts of offices if possible
2.20	Reuse direct/indirect lighting fixtures from 2nd floor
2.21	Recycle carpet and buy new "green" carpet

	OPERATION OF SYSTEMS DISCUSSION
2.22	Base building systems efficiency considerations: Existing steam boilers (natural gas fired) ? Evaluate boiler efficiency and size – they are in OK condition, but may be oversized for One Lincoln Plaza ? Evaluate adding smaller, high efficiency boiler ? Existing burners ? Total replacement ? DHW
2.23	Investigate feasibility of selling excess steam to Cresset. Meter it and charge based on actual usage. A good synergy because occupancy schedules complement each other
2.24	Rooftop cooling towers need to be replaced. They can probably last another couple of seasons. Replacement can only happen in the spring or fall. Replacement alternatives to consider: ? Quantity ? Type (efficiency and cost)
2.25	Pumping systems – change to variable speed pumps
2.26	Rooftop ventilation and filtration
2.27	Building control system (identified as a priority in achieving sustainable design goals by TSNE) ? Base building only controls vs. whole building ? Occupancy controls ? Carbon dioxide controls
2.28	Renewable energy opportunities – existing emergency generator is diesel powered, there is no plan to replace it at this time
2.29	Lighting alternatives (identified as a priority in achieving sustainable design goals by TSNE) ? Daylighting ? Low energy options
2.30	Plumbing alternatives – there is no plan to replace fixtures at this time, but these alternatives should be considered when the time comes to replace them ? Waterless urinals ? Low flow or dual flow fixtures
2.31	Occupant usage – Energy star rating

2.32	Space fit-up considerations: Zone size vs. heat pump quantity and cost
2.33	Distribution alternatives – consider working floor plan layouts around existing duct layouts to save on costs
	FINISHES AND MATERIALS DISCUSSION
2.34	Investigate alternatives to gypsum drywall for interior partitions
2.35	Investigate furniture options with consultant
2.36	Priority for daylight
2.37	Translucent panels at private offices will allow daylight through, but will preserve privacy. Acoustical insulation will be needed in office walls for acoustical privacy.
2.38	Reuse existing tracks for blinds and investigate alternatives for blinds (aluminum vs. PVC)
2.39	Expose the arched windows at east wall by raising the ceiling height
2.40	Expose the structure if possible in open areas only, by removing ceiling like on the 2nd floor
2.41	Reuse ceiling tiles and replace as needed (salvage from other floors and from Essex Street). Possibly paint existing ceiling tiles for a fresher look.
2.42	Need to come to agreement with Cresset re: demo and reuse of materials and resources from Essex Street building – would like to salvage as much as possible (ceiling, white boards, tack boards, some light fixtures) that would not be reused in residential use
2.43	No interest in raised access flooring
2.44	New carpeting (carpet tile preferred) with high recycled content, low VOC – recycle all existing carpet that is removed
2.45	Willing to pay extra for linoleum – prefer linoleum ties in a pattern
2.46	Educated maintenance staff will add to longevity of materials
2.47	Some demountable partitions that can be moved (partitions would need to be moved 3 times for cost to be worth it compared to GWB walls) – follow up conversation needed with furniture consultant
2.48	Use zero VOC paints
2.49	Consistent priority is more daylight – whether it is achieved with higher ceilings or more interior glazing. Decision will be based on which solution provides more daylight to more of the occupants
2.50	If 80% of occupants are happy than the project is considered a success
2.51	Glazing in offices is as much to promote connectedness as it is to enhance daylighting

Appendix B. HVAC Recommendations

To:		Date:	9/20/2004
From:	Daniel A. Kocur, PE	Project No.:	04062.02
Project:	Third Sector New England – 89 South Street		
Re:	Mechanical Systems and Equipment Survey and Recommendations		
Distribution:	(MF)		

Mechanical Investigation:
The following is a review of the field investigation performed on Thursday September 16, 2004. See the attached sheet for the nameplate information of the mechanical equipment surveyed.

1. Condenser Water Pumps: There are three condenser water pumps, labeled P-1, P-2 and P-2A. Two pumps are 1,150 GPM @ 50 HP and the third is 500 GPM @ 20 HP. All three pumps are Weinman/Mueller base mounted end suction pumps. Pumps P-1 and P-2 were manufactured in August 1985 and P-2A was manufactured in July 2000. ASHRAE Applications Handbook indicates that the estimated service life of a base mounted pump is 20 years. The three pumps appear to be well maintained and in good working condition. According to a flow diagram dated 3-25-85 by Stahl/Greenleaf Associate, the three pumps are constant volume. The 500 GPM pump operates during periods of light loads, and as the load increases the 1,150 GPM pumps are energized to maintain the increasing load. At full load, both 1,150 GPM pumps are operational. The buildings maintenance supervisor indicated that the pumps are currently being controlled manually because the original control panel is not operational. The majority of the condenser water is piped the first floor and then distributed to risers, this provides condenser water to heat pumps stacked in the same location on each floor. There are 6” condenser water supply and return pipes that leave the boiler room and route to the 70 Lincoln Street building.
2. Hot Water Pumps: There are two hot water pumps, labeled P-3 and P-3A. The pumps were sized to provide 225 GPM @ 10 HP. The pumps are Weinman/Mueller base mounted end suction pumps; they were manufactured in

August 1985. ASHRAE Applications Handbook indicates that the estimated service life of a base mounted pump is 20 years. The pumps appear to have been well maintained, and are in good working condition. According to the flow diagram described above, one of the hot water pumps operates while the other is a stand-by. There are 2½” hot water supply and return pipes that leave the boiler room and are routed to the 70 Lincoln Street building.

3. Steam Boilers: There are two HB Smith cast iron steam boilers labeled B-1 and B-2. Each boiler is comprised of 16 sections, which has a maximum steam output of 4,076 MBH and requires a natural gas input of 6,540 CFH. The age of the boilers is not known, but during the renovation design done by Stahl/Greenleaf Associates in 1985, they were described as existing. ASHRAE Applications Handbook indicates that the estimated service life of a cast iron steam boiler is 30 years. Each boiler has a 5 HP dual fuel combustion power burner and ¾ HP induced draft fan. The oil tank, which served the boilers, has been removed and the boilers are now run exclusively on natural gas. Combustion air is provided by a 36” x 18” duct. It is routed to within 12 inches of the floor and provided with a wire mesh screen. The other end of the combustion duct is open ended with a wire mesh screen in the wall of the loading dock area. There is a 4” steam supply and a 2½“ condensate return that leave the boiler room and are routed to the 70 Lincoln Street building.
4. Heat Exchangers: The heat pump and hot water systems are provided with a steam to hot water heat exchanger. The make model and size of these heat exchangers could not be verified on site due to the insulation. The 1985 design documents by Stahl/Greenleaf Associates indicate the heat pump system heat exchanger was sized to provide 340 GPM of hot water at a temperature difference of 30?F. It also indicates the hot water system heat exchanger was sized to provide 225 GPM of hot water at a temperature difference of 22?F. The schedule indicated the steam input to these heat exchangers was 5,000 lbs/hr and 2,400 lbs/hr of 10 lb steam. The age of the heat exchangers could not be verified. The ASHRAE estimated service life for shell-and-tube heat exchangers is 24 years. They appear to be in good condition.
5. Closed Circuit Coolers: There are two EVAPCO closed circuit coolers installed on the roof. Each cooler is capable of providing 3,150 MBH of heat rejection. The age of the cooling towers is approximately 20 years and the ASHRAE estimated service life for cooling towers is 20 years. The manufacturer tasked a mechanic to assess the condition of the coolers in February of 2004. This was in response to a request by Allied Consulting Engineering, Inc. The results were presented in a report by Allied and a copy of the mechanics findings is attached to this report. The report indicated that the outlet dampers are in poor condition and the basin heaters are not operational.
6. Floor Smoke Exhaust Fans: Currently the floors of the building are provided with smoke exhaust via three roof mounted centrifugal utility fans. Each of the fans is ducted to provide smoke exhaust from different areas of each floor. The three fans seem to have been maintained well and appear to be in good working condition.
7. Stair Pressurization Exhaust Fans: Each of the two stair towers is provided with a centrifugal utility fan to provide exhaust from the stairs. Two inline fans provide

air at the base of the stairs, which is, sized approximately 25% larger than the exhaust fans to maintain a positive pressure within the stairs.

8. Energy Recovery Ventilator: An energy recovery ventilator provides outside air to each floor of the building. The return side of the system is exhaust air from the toilet rooms on each floor. The supply air from the unit is split into three risers, with one riser being within the Future Cresset space.
9. Boiler Room Ventilation Fan: a centrifugal inline exhaust fan provides Boiler room ventilation.

Recommendations:

Block heating and cooling loads were performed for the Third Sector New England portion of the 89 South Street building. The following is a list of design criteria used in the calculation.

- ✍ Outside design conditions are per Massachusetts State Building Code, Chapter 13.
    - o Summer Design Temperatures 87?F db / 74?F wb
    - o Winter Design Temperature 7?F
- ✍ Indoor design conditions are as follows:
    - o Summer – 75?F
    - o Winter – 72?F
- ✍ Building envelope U-values used are as follows:
    - o Walls – 0.640 Btu/hr/?F/ft^2
    - o Windows – 0.550 Btu/hr/?F/ft^2, this is consistent with a double glazed clear window with an air space and aluminum frame. Various double-hung windows are installed.
    - o Roof – 0.530 Btu/hr/?F/ft^2
- ✍ Building internal loads are as follows:
    - o Lighting load – 1.5 watts/ft^2
    - o Equipment load – 3.0 watts/ft^2
    - o People load – 120 ft^2/person was used to estimate the occupancy of 925 people. 245 Btu/hr/person sensible and 205 Btu/hr/person latent was the heat gain used per person.
- ✍ Building infiltration is estimated at 0.3 cfm/ft^2 of exterior wall area, which is a good rule of thumb for average tightness buildings.
- ✍ Outside air required was calculated on a per person bases using 925 people at 20 cfm/person.

The calculated heating and cooling loads are 2,980 MBH and 3,960 MBH respectively. The existing boilers are capable of producing 8,152 MBH IBR net of heating. The existing closed circuit coolers are capable of rejecting 11,500 MBH. The existing equipment, boiler and closed circuit cooler, are oversized by 63% and 66% respectively.

Appendix C. Project LEED Scorecard

LEED-CI Pilot Project Scorecard

#REF!
#REF!
#REF!

		Anticipated	Possible	Earned	
Sustainable Sites					
Credit 1	Site Selection				
	LEED Certified Building (3 points) [1.0.1]				
	or				
	Ozone Depleting Materials (1/2 point) [1.0.2]				
	Non-polluting Source-renewable Energy (1/2 point) [1.0.3]				
	Operable Windows (1/2 point) [1.0.4]		0.5		TBD
	Brownfield Site (1/2 point) [1.0.5]				
	Heat Island Effect, Roof (1/2 point) [1.0.6]		0.5		
	Light Pollution Reduction (1/2 point) [1.0.7]				
	Heat Island Effect, Non-Roof (1/2 point) [1.0.8]				
	Water Efficient Landscaping, Reduce by 50% (1/2 point) [1.0.9]				
	Innovative Wastewater Technologies (1/2 point) [1.0.10]				
	Water Use Reduction, 20% Reduction (1/2 point) [1.0.11]				
	[Others: type over] [1.0.12] Potential MEP upgrades to Bldg		0.5		TBD
	[Others: type over] [1.0.13] Historical Landmark Building Selection		0.5		TBD
	[Others: type over] [1.0.14]				
Credit 2	Development Density	1			
Credit 4.1	Alternative Transportation, Public Transportation Access	1			
Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1			
Credit 4.4	Alternative Transportation, Parking Capacity	1			
	Sustainable Sites Totals	*4*	*1*		
Water Efficiency					
Credit 3.1	Water Use Reduction, 20% Reduction				
Credit 3.2	Water Use Reduction, 30% Reduction				
	Water Efficiency Totals				
Energy & Atmosphere					
Prerequisite 1	Fundamental Building Systems Commissioning	Y			
Prerequisite 2	Minimum Energy Performance	Y			
Prerequisite 3	CFC Reduction in HVAC&R Equipment	Y			R-22
Credit 1.1	Optimize Energy Performance, Lighting Power	1			
Credit 1.2	Optimize Energy Performance, Lighting Controls	2			
Credit 1.3	Optimize Energy Performance, HVAC	1	1		
Credit 1.4	Optimize Energy Performance, Equipment & Appliances		1		TBD
Credit 3	Additional Commissioning		1		
Credit 5.1	Measurement and Verification, Sub-Metering				
Credit 5 .2	Measurement and Verification, Energy Costs Paid By Tenant				
Credit 6	Green Power				
	Energy & Atmosphere Totals				
		4	*3*		

Materials & Resources					
Prerequisite 1	Storage & Collection of Recyclables	Y			
Credit 1.1	Building Reuse, Long Term Lease				
Credit 1.2	Building Reuse, Maintain 40% of Non-Shell Systems		1		TBD
Credit 1.3	Building Reuse, Maintain 60% of Non-Shell Systems		X		
Credit 2.1	Construction Waste Management, Divert 50% From Landfill	1			
Credit 2.2	Construction Waste Management, Divert 75% From Landfill		1		
Credit 3.1	Resource Reuse, Specify 5%		1		
Credit 3.2	Resource Reuse, Specify 10%		X		
Credit 3.3	Resource Reuse, Specify 30%				
Credit 4.1	Recycled Content, Specify 5% PC or 10% PC+PI	1			
Credit 4.2	Recycled Content, Specify 10% PC or 20% PC+PI		1		
Credit 5.1	Regional Materials, 20% Manufactured Regionally				
Credit 5.2	Regional Materials, 10% Extracted Regionally				
Credit 6	Rapidly Renewable Materials				
Credit 7	Certified Wood				
	Materials & Resources Totals	*2*	*4*		
Indoor Environmental Quality					
Prerequisite 1	Minimum IAQ Performance	Y			
Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	Y			
Credit 1	Carbon Dioxide (CO_2) Monitoring		1		TBD
Credit 2	Ventilation Efficiency				
Credit 3.1	Construction IAQ Management Plan, During Construction	1			
Credit 3.2	Construction IAQ Management Plan, Before Occupancy		X		
Credit 4.1	Low-Emitting Materials, Adhesives & Sealants		1		
Credit 4.2	Low-Emitting Materials, Paints	1			
Credit 4.3	Low-Emitting Materials, Carpet	1			
Credit 4.4	Low-Emitting Materials, Composite Wood				
Credit 4.5	Low-Emitting Materials, Furniture and Furnishings				
Credit 5	Indoor Chemical & Pollutant Source Control				
Credit 6	Controllability of Systems				
Credit 7.1	Thermal Comfort, Compliance with ASHRAE 55-1992				
Credit 7.2	Thermal Comfort, Permanent Monitoring System				
Credit 8.1	Daylight & Views, Daylight 75% of Spaces				
Credit 8.2	Daylight & Views, Views for 90% of Spaces	X			
	Indoor Environmental Quality Totals	*3*	*2*		
Innovation & Design Process					
Credit 1.1	Innovation in Design - Green Housekeeping program		1		TBD
Credit 1.2	Innovation in Design - Owner / Tenant common areas		1		
Credit 1.3	Innovation in Design				
Credit 1.4	Innovation in Design				
Credit 2	LEED™ Accredited Professional	1			
	Innovation & Design Process Totals	*1*	*2*		
TOTAL		14	12		

Potential LEED Rating

Certified: (21 to 26 points) Silver: (27 to 31 points) Gold: (32 to 41 points) Platinum: (>= 42 points)

Appendix D. Projected Energy Modeling Results

Third Sector New England DOE2 LEED Modeling Results

Energy Summary By End Use

End Use	Energy Type	Proposed Building Energy (MBtu/yr)	Proposed Building Peak (kBtu/h)	Budget Building Energy (MBtu/yr)	Budget Building Peak (kBtu/h)	Propose / Budg Energ (%
Lighting - interior	Electricity	861.9	357.3	1511.4	480.6	57
Lighting - exterior	Elec-unregulated	0	0	0	0	n.
Space heating (1)	Electricity	1239.8	1731.1	2111.4	2444.4	59
Space heating (2)	Fuel	9990	2191	16103	3697	62
Space cooling	Electricity	1094.5	1540.6	1657.7	1990.5	66
Pumps	Electricity	257.9	86.3	1221.3	185	21
Heat Rejection	Electricity	0	0	0	0	n.
Fans	Electricity	1032.7	271	1532.2	330	67
Service water heating	Fuel	8412	319	15382	583	55
Misc Equipment	Elec-unregulated	644.7	240.3	872	277.1	74
Total Building Consumption		23533.5		40391		58

Regulated Energy Use and Cost Summary By Fuel Type

	Proposed Building Energy (MBtu/yr)	Proposed Building Cost ($/yr)	Budget Building Energy (MBtu/yr)	Budget Building Cost ($/yr)	Proposed / Budget Energy (%)	Propose / Budg Cost (%
Electricity	4486.8	$271,063.00	8034	$400,357.00	56%	67.70
Fuel	18402	$50,216.00	31485	$47,512.00	58%	105.70
Other fossil fuel						
District steam						
Total nonsolar	22888.8	$321,279.00	39519	$447,869.00	58%	71.70
Renewable Fuel		$22,329.00				
Solar or site recovered		$37,979.00				
Total including Solar		$305,629.00		$447,869.00		
				LEED Savings %		31.76